Remarks/Arguments

The Examiner is thanked for the careful review of this application. Claims 1-19 were previously cancelled and claims 20-38 are currently pending. Claims have been amended to better define the claimed condition for appeal. Amendments do not introduce new matter.

The Applicants thank the Examiner for granting the Applicant an Examiner's Interview, which was conducted on June 14, 2005. During the telephonic Examiner's interview, the Office indicated that the Office's strongest rejection is based on Huang in view of Chen. At the conclusion of the Interview, the Applicant was asked to submit evidence of unexpected results. In response to the Office's request, the Applicant respectfully submits the Declaration under 37 CFR sections 1.131 and 1.132 of Douglas L. Keil (hereinafter referred to as "Keil Declaration").

Rejections under 35 U.S.C. § 103(a)

The Office has maintained rejection of the claims under the cited prior art.

Declaration under 37 CFR section 1.132:

Several of the Office's rejections rely on Chen and/or Huang. Specifically, the Office has interpreted that Chen's teaching of stripping photoresist using oxygen plasma or a solvent such as ACT-690 is an express suggestion to substitute one equivalent component or process for another. As the Applicant has indicated in the Applicant's previously filed responses, in arriving at such a conclusion, the Office has disregarded that Chen only teaches using plasma oxygen or ACT-690 to strip photoresist from over an inorganic dielectric layer which does not have low dielectric constant (in particular, SiO_2).

As evidenced by the attached Keil Declaration, high selectivity of DMSO with respect to the exposed organic low dielectric constant material was not commonly known by one of ordinary skill in the art at the time the claimed invention was documented. The Applicant brings the Office's attention to the following excerpt, on page 9, lines 8-18 of the specification, which provides:

> . . . It has been found that DMSO, which preferably of a high pressure liquid chromatography (HPLC) grade, removes the photoresist material by chemical dissolution but does not significantly damage either dielectric layer 14, hard mask layer 16, or ARC layer 18. In fact, optical measurements and SEM analysis have determined that there is no significant loss of the low K material during the stripping operation.
>
> This result is surprising because the photoresist material and the low K material from which dielectric layer 14 is formed are both organic materials. In addition, in many instances, ARC layer 18 also may be an organic material. Thus, it has been discovered that DMSO unexpectedly exhibits selectivity toward low K materials in that it does not chemically attack such low K materials, whereas DMSO does chemically attach conventional photoresist

materials.. . . [Emphasis added.]

Specifically, as evidenced by the attached Keil Declaration, at the time of the invention, DMSO was known to have high selectivity toward inorganic dielectric materials, which do not have low dielectric constants. However, at the time of the subject invention, it was not well known that same could be true with respect to organic low dielectric constant materials. In fact, people of ordinary skill in the art expected the opposite.

The Applicant respectfully submits that at the time the claimed invention was conceived, it was well known that DMSO was an organic solvent. As such, it was expected that DMSO would attack the exposed portion of the organic low dielectric constant material if DMSO were used to remove photoresist when a portion of the underlying organic low dielectric constant layer was exposed. The latter is true because one of ordinary skill in the art is well aware that the chemistry of an organic low dielectric constant material is significantly different from the chemistry of an inorganic material having non-low dielectric constant. As such, one skilled in the art would not have necessarily concluded that what might be applicable to inorganic non-low dielectric materials would be equally applicable to organic low dielectric constant materials. Nor would a person of ordinary skill in the art expect that the results would be identical in both scenarios.

Furthermore, as asserted in the Applicant's responses, Huang does not teach using oxygen plasma to remove photoresist when a portion of an organic low dielectric constant layer is exposed. Rather, Huang teaches exactly the opposite. In the Final Office Action, the Office has stated that:

> Applicant's argument that Huang et al teaches away from using oxygen plasma to remove photoresist (pg 9, firs full paragraph) is noted but is not found persuasive. Huang et al merely teaches a process, which is an improvement over the prior art process. Huang et al does not teach away from using oxygen plasma to remove photoresist, as suggest by applicant. Huang et al teaches the prior art using oxygen plasma to remove photoresist (col , ln 45-60) and Huang et al also teaches using oxygen plasma to remove photoresist in the improved process (col 3, ln 35-40; col 4, ln 15-20; Fig 2C and Fig 3C). Huang et al does not teach away from using oxygen plasma to remove photoresist because Huang et al teaches using oxygen plasma to remove photoresist. [Emphasis added.]

The Office seems to have misunderstood the Applicant's assertion. On first paragraph, page 8 of the Applicant's Request for Reconsideration filed on October 25, 2004, (the Applicant assumes that the Office meant to refer to page 8), the Applicant provides:

> . . . However, the same section of Huang cited by the Office also teach [sic] that due to the organic low K dielectric including carbon, plasma etching the photoresist using oxygen plasma, thus negatively resulting in the removal of the organic low K dielectrics, as well.. . . Thus, Huang, alone,

> teaches away from using plasma etching (as well as any alleged method equivalent to plasma etching) to remove photoresist from over low constant dielectric layers as well as organic low K dielectric layers. [Emphasis added.]

As illustrated, the Office may have overlooked that the Applicant's arguments are specifically directed at not using oxygen plasma to remove photoresist when an organic low dielectric constant layer is exposed. In fact, in the Office's response, the Office eliminated any reference to low dielectric constant material or organic low dielectric constant material or that the Applicant's argument are directed at an organic low dielectric constant layer.

The Applicant respectfully brings the Office's attention to the following excerpts from Huang (some or portions of the excerpts have even been cited by the Office). The following except of Huang (column 1, lines 61-67 and column 2, lines 1-2) provides:

> In the he[sic] above method, the formation of a low k dielectric layer 12 in the process of interconnection has quite a few disadvantages. While removing the photo-resist 14, since the dielectric material is very similar to the photo-resist material, for example, both containing a large proportion of carbon, part of the low k dielectric layer 12 within the opening 15 is removed too. [Emphasis added.]

Recognizing such disadvantage, Huang focuses on eliminating the problems by defining a cap insulation layer 24 that is made out of silicon nitride. In column 3, lines 28-41, Huang provides:

> The formation of the cap insulation layer 24 is the characteristic of the invention. With the cap insulation 24, the dielectric layer is protected from being etched by plasma containing oxygen during the subsequent process.. . .
>
> Referring to FIG. 2C, using plasma containing oxygen as a clean agent, the photo-resist layer 25 is removed. The dielectric layer 22 is not etched being covered and protected by the cap insulation layer 24 and the insulation masking layer 23.. . . [Emphasis added.]

In short, Huang has eliminated the problem by never exposing the underlying organic low dielectric constant layer. Thus, the teachings of Huang merely confirm the Applicant's assertions as well as Chen's teachings that plasma etching can be used to remove photoresist from over SiO_2 (i.e., inorganic non-low dielectric constant material). Huang further confirms the Applicant's assertion that oxygen plasma should not be used to remove photoresist when a portion of the underlying organic low dielectric constant layer is exposed. Accordingly, Chen or Huang cannot be used to establish equivalency of using oxygen plasma and ACT-690 when a portion of an organic low dielectric constant layer is exposed. As such, the Applicant respectfully submits that Chen or Huang not be applied against the claims.

Declaration under 37 CFR section 1.131:

Liu forms the basis for several rejections set forth in the Office Action. It is noted that Liu was filed on November 16, 1998. The subject patent application, was filed on March 22, 1999 and relies for priority on a provisional patent application No. 60/114,493 filed on December 31, 1998. Thus, the effective date of the subject patent application is approximately one (1) month after the filing date of Liu. However, as evidenced by the attached Keil Declaration, the claimed invention was conceived in February of 1998, first entered into the inventor's notebook in August of 1998, documented in the Disclosure Form on October 12, 1998, transmitted to the legal department of the Assignee on October 12, 1998, and was stamped received by the legal department on October 15, 1998. Please see the attached Keil Declaration filed under 37 CFR §§ 1.131 and 1.132 and supporting evidence.

Thus, the invention date of the claimed invention is prior to the filing date of Liu. Furthermore, having the prior invention date of the subject application is coupled with due diligence from prior to the filing date of Liu to the filing of the provisional patent application. As such, the submitted evidence is sufficient to establish all that is required to antedate Liu in accordance with 37 CFR section 1.131. Accordingly, the Applicant submits that Liu is no longer prior art against the claimed invention.

Accordingly, it is respectfully submitted that independent claims 20, 26, and 34 are patentable over any combination of the cited art of record. Likewise, dependent claims 21-25, 27-33, and 35-38 are also submitted to be patentable over the cited art of record for at least the same reasons discussed above. Accordingly, the Applicant respectfully requests that the § 103(a) rejections be withdrawn.

In view of the foregoing, the Applicant respectfully submits that all of the pending claims 20-38 are in condition for allowance. Accordingly, a Notice of Allowance is respectfully requested. If the Examiner has any questions concerning the present Request for Reconsideration, the Examiner is kindly requested to contact the undersigned at (408) 774-6913. If any fees are due in connection with filing this Amendment, the Commissioner is also authorized to charge Deposit Account No. 50-0805 (Order No. LAM2P266).

Respectfully submitted,
MARTINE PENILLA & GENCARELLA, L.L.P.

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Customer Number 25920

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:	Docket No: LAM2P266
John E. LANG	Group Art Unit: 1765
Application No: 09/274,194	Examiner: M. Song
Filed: October 16, 2001	Date: August 15, 2005
For: METHOD OF REMOVING PHOTORESIST MATERIAL WITH DYMETHYL SULFOXIDE	

DECLARATION UNDER 37 C.F.R. SECTIONS 1.131 AND 1.132

I, Douglas L. Keil, declare as follows:

1. I earned an undergraduate degree in Physics from the University of Wisconsin-Milwaukee, and a Ph.D. degree in Physics from the University of Wisconsin-Madison. I graduated in 1994 with a thesis in Plasma Physics. I currently work in the Etch Department of Lam Research Corporation (hereinafter, "Lam"), and have been employed by Lam since January 1997. For the past eight (8) years, I have been working in the area of etching dielectrics, and specifically, plasma etching of dielectrics.

2. I remember reading and understanding the Lam Research Invention Disclosure Form, dated October 12, 1998 (hereinafter, "Disclosure Form") prepared and printed by John E. Lang, the inventor of the above-identified patent application (hereinafter, "the Subject Application") on October 12, 1998. When reading the Disclosure Form, I noted that the Disclosure Form provided a conception date of February 1998 and a first notebook entry date of August 1998. I remember witnessing and signing the Disclosure Form on October 12, 1998. A true copy of the Disclosure Form that has my signature is attached herein as Exhibit 1.

3. I remember that upon reading the Disclosure Form, I was in agreement with Mr. Lang's statement that in February of 1998, no liquid was commonly recognized or known in the industry to have the capability of dissolving photoresist material without harming the exposed organic low dielectric constant material.

4. I remember that until I read the Disclosure Form, I did not know what would be the results of applying dimethyl sulfoxide (hereinafter refer to as "DMSO") to photoresist

Appendix A

material in the presence of organic low dielectric constant material. Furthermore, I remember being surprised when I learned that DMSO could dissolve the photoresist material without attacking the exposed organic low dielectric constant material. As of the date of the Disclosure Form, it was my understanding that DMSO did not have high selectivity toward organic low dielectric constant materials (i.e. DMSO can remove organic low dielectric constant materials) .

5. I remember being surprised when I read that DMSO has high selectively toward organic low dielectric constant materials (i.e. DMSO would not remove the organic low dielectric constant materials). I remember that upon reading the Disclosure Form, I was in agreement with Mr. Lang that up until I read the Disclosure Form, I did not know that a liquid existed which was capable of dissolving photoresist material without harming the underlying organic low dielectric constant material. I recalled that DMSO was commonly known to be an organic solvent. Accordingly, similar to other organic solvents, I expected that DMSO would attack the organic low dielectric constant material if DMSO were to be used to remove photoresist when a portion of the underlying organic low constant dielectric layer was exposed. I remember being surprised that DMSO did not attack the underlying low-k and attributed the results to the significant differences between the chemistries of organic low dielectric constant materials and the chemistries of inorganic non-low dielectric constant materials.

6. To the best of my knowledge, in February of 1998, DMSO was not being used to dissolve photoresist material formed over a hard mask layer when a portion of an organic low dielectric constant layer is exposed through an opening in the mask layer.

7. I declare that all statements made herein of my own knowledge are true; that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing therein.

Douglas L. Keil
Douglas L. Keil

8/15/2005
Date

Appendix A

Invention Disclosure No: P0483

Lam RESEARCH

Invention Disclosure

Name: John Lang

Date: October 12, 1998

Tel No: (510)572-8453 **Fax No:** (510)572-8256

Internal e-mail (MSMail or TeamLinks): john.lang@lamrc.com

1. **Project Name: DMSO**

2. **Title or subject matter of your invention: Wet chemical resist removal with selectivity to low k materials.**

3. **Give a brief yet thorough description of what your invention is and how your invention operates or performs. Describe the preferred and alternative ways in which your invention would be implemented. Attach and identify copies of all known drawings, sketches, (flow-charts for software), formulae, descriptions, data, articles, etc., of your invention, including dated and witnessed copies of your lab notebook entries: The chemical known as DMSO or dimethyl sulfoxide was HPLC grade. Using dimethyl sulfoxide as a resist solvent in an ultrasonic cleaner removed the organic layer without harming BCB, Flare, or SiLK. The films were optically measured and SEMed with no loss. The DMSO can be removed by an ultrasonic bath. I hope to put DMSO on a tool to check dry chemical etch rate.**

4a. **Describe any prior art (e.g., known existing products, methods, publications or patents) of which you are aware and which relate to your invention: None that I am aware of.**

Exhibit 1

4b. State in detail the advantages that your invention has over this prior art and how your invention distinguishes over this prior art: Selectivity to the low k materials. Pre stripping resist increases etch rate and discourages hard mask erosion with more surface area available which translates to better CD control. No gas or liquid to date has this unique property of removing resist without harming another organic (low k) material.

5. Conception/Reduction/Commercial Use:
Date of first conception: February 98_____
Date of first notebook entry: August 98_____
Where conceived?: At home reading organo-silane chromatography catalog. __
Was invention reduced to practice (made/used)? (yes/no): used as liquid first. Yes it was tried.
If yes, date first reduced: September 22, 1998_____
Is commercial or public use planned (yes/no):don't know yet. _____
If yes, date of expected or actual public disclosure or offer for sale: _____
Was invention result of co-development project with others? (yes/no): no_____
If yes, explain (include whether NDA in place):

6. Did invention occur during performance of a government contract? (yes/no): no_____
If yes, explain:

7. Give names of other persons familiar with or who have worked on the project , but who do not claim an inventorship interest in the invention (please identify the project or intended product): none

Exhibit 1

Invention Disclosure No: _____

8. **For <u>each</u> inventor, please provide the following information (copy & paste as necessary):**

Legal Name (as you intend to sign application): John E. Lang_____

Employee #: 8329_____
Dept #: 471_____
M/S: CA-03#200A_____
Extension: 8453_____
e-mail: john,lang@lamrc.com_____
Names of Supervisor, Director, and Vice President: Ian Morey, Graham Hills, Greg Cambell
_____
Residential Address (City, County, State & Zip): 1559 Dennis Ave Milpitas, CA 95035_____
_____
Mailing Address (if different from Residential): _____
Citizenship: USA_____

9. **Inventor's Signature(s) and date signed:**

John E. Lang October 12, 1998

10. **Witnessed & Understood By (include date):**

Douglas Keil 10/12/98

THIS FORM IS Lam RESEARCH NEED-TO-KNOW CONFIDENTIAL DATA WHEN FILLED IN. Please send the completed form to Jeff Brooks, Intellectual Property Counsel, Lam Research Corp., Law Department, M/S ENG-900, 4650 Cushing Pkwy, Fremont CA 94538.

Exhibit 1